

Large Scale Networking (LSN)

LSN Agencies: NSF, NIH, DOE/SC, DARPA, NSA, NASA, AHRQ, NIST, OSD, NOAA, DOE/NNSA
Other Participants: DHS, FCC, USGS

LSN members coordinate Federal agency high-performance networking R&D in leading-edge networking technologies, services, and enhanced performance including programs in advanced network components, optical network testbeds, security, infrastructure, and middleware; grid and collaboration networking tools and services; and engineering, management, and use of large-scale networks for scientific and applications R&D.

President's 2006 Request

Strategic Priorities Underlying This Request

- By 2008, science cooperation and model development in high-energy physics, bioinformatics, weather, astrophysics, and other areas will require near-real-time petabyte and above data transfers. Current technology and the Internet Protocol (IP) will not scale to this level. This need is addressed by 2006 LSN coordination on optical networking testbeds to develop the generalized multi-protocol label switching (GMPLS) protocol, interdomain resource reservation and management, and optical networking protocols and switches.
- Secure interdomain cooperation and collaboration is hindered by lack of a scalable authentication, authorization, and accounting protocol (AAA). In 2006, the LSN agencies will cooperatively develop an AAA interagency testbed with the aim of later expanding the AAA protocols to larger-scale networks. They are also developing security best practices and new technologies such as automated intrusion response.
- Optimizing application performance over networks is severely constrained by lack of visibility into the interior of networks. Joint Engineering Team (JET) members are coordinating implementation of standard measurement boxes and standard protocols allowing end-to-end tuning of application performance.

Highlights of Request

Promote development and coordination of Optical Networking Testbeds (ONTs): NSF's CHEETAH and DRAGON networks, DOE/SC's UltraScience Net, and coordination with OMNInet, National Lambda Rail, and regional ONTs. These testbeds are developing GMPLS, agile circuit-switching, and interdomain control plane tools, services, and management (e.g., resource reservation, security). Collaborative activities include:

- **All:** Coordination of network backup during times of stress, outage, or national emergency
- **All:** Coordination on OMB's call for cybersecurity implementation
- **DOE/SC, NSF:** End-to-end agile networking
- **DOE/SC, NSF:** High speed transport protocol
- **DOE/SC, NSF, others:** End-to-end QoS/GMPLS
- **DARPA, NSA, NSF, OSD:** End-to-end network performance measurement
- **DARPA, NSF, FCC:** Programmable wireless networking (ProWin) and networking of sensor systems (NOSS)
- **DHS, DOE/SC, NSF, OSD:** Network security research

Planning and Coordination Supporting Request

- **Co-funding:** NSF networking research projects (e.g., cyber security, fundamental network research) receive support from DARPA, DHS, DOE/SC, and NSA
- **Workshops:** Follow-up meeting on 2004 JET Roadmap Workshop co-sponsored by DOE/SC, NSF to plan joint activities; LSN ONT Workshop, August 2004 to plan 2005-06 activities; 2005 NSF Cybersecurity Follow-on Workshop; DOE/SC National Collaboratories Workshop to plan 2005-06 programs
- **Coordination by LSN Teams:**
 - **Joint Engineering Team (JET):** DOE/SC, NASA, NIH, NIST, NOAA, NSA, NSF, OSD, USGS, with national labs, universities, and vendors (ANL, ARSC, CAIDA, Cisco, CSC, FIU, Internet2, ISI, IU, Juniper, MAX, NLANR, Qwest, StarLight, UIC, UMd, UNC, UW) – ONTs; engineering research networks (JETnets); security best practices; applications testbeds (IPv6, IPv6 multicast, performance measurement); metrics and monitoring: interdomain, end-to-end, internal network visibility;

recommendations: 9,000-byte MTU; international coordination

- **Middleware and Grid Infrastructure Coordination (MAGIC) Team:** DOE/SC, NIH, NIST, NOAA, NSF, with national labs, universities, and vendors (ANL, Boeing, Cisco, Educause, Fairfield Technology, HP, IBM, Internet2, ISI, LANL, Level3, LBL, Microsoft, PNL, UCAR, UIUC, Umd, UWisc) – middleware and Grid tools and services; collaboration infrastructure; applications; security, privacy (coordinate certificate authorities); standards development; international coordination
- **Networking Research Team (NRT):** DARPA, DOE/SC, NASA, NIST, NSA, NSF – basic research (technology and systems); prototyping/testing optical networks (dynamic provisioning, GMPLS-based control plane); applications; wireless, nomadic networking (ad hoc, mobile); education and training
- **Information exchange:** Multiagency LSN program manager participation in review panels, informational meetings, principal investigator (PI) meetings; monthly LSN, JET, MAGIC, and NRT meetings; tactical coordination among program managers with common interests; DOE ESSC meetings coordinated with Internet2 Joint Techs Meetings; GMPLS working group coordinating development of inter-domain signaling in agile optical networks

2005 and 2006 Activities by Agency

NSF: Sponsorship at universities of fundamental networking research (architectures, fundamental design, control and management, innovative technologies, extensible networks, strategic research); networking of sensor systems (network programming, hardware/software, architecture, privacy/security, protocols, and algorithms); programmable wireless networks (dynamic spectrum management, topology discovery, robust/secure architecture, applications development, management); CAREER awards for networking research; network security (intrusion/attack detection and prevention, network forensics, critical systems protection, survivable designs and protocols); infrastructure development (create, test, and harden next-generation systems); optical networking testbeds (DRAGON, CHEETAH, applications development, security, GMPLS, interdomain services, bandwidth on demand)

NIH: Testbed projects to demonstrate QoS, security and medical data privacy, nomadic computing, network management, collaboratory infrastructure technology; Biomedical Informatics Research Network (BIRN)

DOE/SC: Middleware and network research (on-demand bandwidth, Grid security, transport protocols, control plane signaling [optical networking], guaranteed end-to-end bandwidth); and network testbeds (Grid3 currently operational); UltraScience Net (research and engineering prototype); QoS/MPLS Testbed (ESnet production network)

DARPA: Self-aware collective systems (resilient, scalable, self-diagnosing, self-healing collections of assets); cognitive networking (self-aware, self-managing networks)

NSA: Wired and wireless location-based services; optical routing and control; quantum communications and quantum key distribution; high-speed information security; pricing models in networking and information assurance

NASA: Space communications and networking (backbone networks and ad hoc networking, energy-efficient integrated communications/networking, data and link layer applications); networking for supercomputing support; projects in Grid computing and space communications end in 2005

NIST: Complex systems (Web service/global information systems, self-managing systems, wireless protocols for healthcare, IP telephony); trustworthy networking (cryptographic standards and applications, smart card security, quantum communications, next-generation protocol architecture, Internet infrastructure protection); networking for public safety; protocols for public safety communications, indoor localization

OSD (HPCMPO): IP end-to-end performance measurement, measurement tools, IPv6 pilots, network security (WAN firewalls and encryption), automated management, IPv6 multicast, and broadband access to Hawaii and Alaska

NOAA: Advanced networking infrastructure including distributed Web servers; computer and network security; applications (collaboratories, Grid computing, storm-scale simulations, wireless, remote operation)

High Confidence Software and Systems (HCSS)

NITRD Agencies: NSF, NIH, DARPA, NSA, NASA, NIST, OSD

Other Participants: AFRL, ARO, DHS, FAA, FDA, ONR

HCSS activities focus on the basic science and information technologies necessary to achieve affordable and predictable high levels of safety, security, reliability, and survivability in U.S. national security- and safety-critical systems. These activities are essential in domains such as aviation, health care, national defense, and infrastructure.

President's 2006 Request

Strategic Priorities Underlying This Request

- Assuring the security, safety, and highly dependable performance of systems and software in critical applications and U.S. infrastructures is one of the most significant and difficult challenges in computing and networking R&D. The technical complexity of these systems continues to grow rapidly in two directions – ever-larger systems of systems involving many millions of lines of code and ever-smaller embedded systems and networks of such systems. As of 2005, the NITRD research community is in the third year of an intensive focus on software and systems assurance arising not only from the new national security climate but also from the rapid emergence of embedded sensor applications in industry; the growing need for secure, reliable IT systems in health care informatics and medical devices; and the increasing complexity of large-scale systems of systems such as the U.S. financial system.
- Agencies' 2006 plans reflect their search for new science-based concepts, technologies, and tools that can revolutionize not only the engineering processes for construction, testing, and certification of software, but also the overall engineering of systems to incorporate high assurance levels at every stage of system design – a new concept in IT R&D. The new area of hybrid and embedded systems such as medical devices offers a rare opportunity to instantiate high assurance from the beginning, not just re-engineer legacy systems.

Highlights of Request

- **NSF:** Develop a new Computer Systems Research program in basic and technology research for high-confidence embedded systems, hybrid control, distributed systems; continue Cyber Trust and Science of Design themes across the divisions of CISE Directorate
- **NSF, DHS:** Continue DETER/EMIST network testbed and experimental framework for network security research launched in 2004
- **DARPA, NSF:** Continue four jointly funded, multi-university projects in Cyber Trust that are developing methods for demonstrating that large software systems are free from flaws
- **NSA, NSF, with NASA, NIST, and other HCSS participants:** Initiate a jointly funded research project on assured and composable, secure, real-time operating systems and middleware. The project will develop an integrated systems and verification technology base for assured systems that are component-oriented, configurable, and coordinated. The goal is to enable future distributed, real-time, embedded systems that have security and assurance built in “from the ground up.”
- **NSA, NSF, with other HCSS agencies:** Verification Grand Challenge Workshop planning
- **NIST:** New activity in high-confidence methods for voting and vote counting

Planning and Coordination Supporting Request

- **HCSS CG and agencies:** Two-part High Confidence Medical Device Software and Systems (HCMDSS) activity – November 2004 workshop planning meeting; June 2005 national workshop on improving design, certification, and operation (by both health care professionals and consumers) of medical device software and systems that will result in better and more cost-effective medical care
- **HCSS CG, FAA:** Aviation workshop planning meeting and workshop to address safety issues in certification of autonomous vehicles and air traffic management; goal is to formulate a research agenda that addresses safety and security and is compatible/compliant with civilian processes.